Command and Control in Campaign Analysis

By Doug "Kupe" Kupersmith

C² in M&S Symposium
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System Simulations Solutions, Inc.
1700 Diagonal Rd, Suite 500
Alexandria, VA 22314
703-684-8268

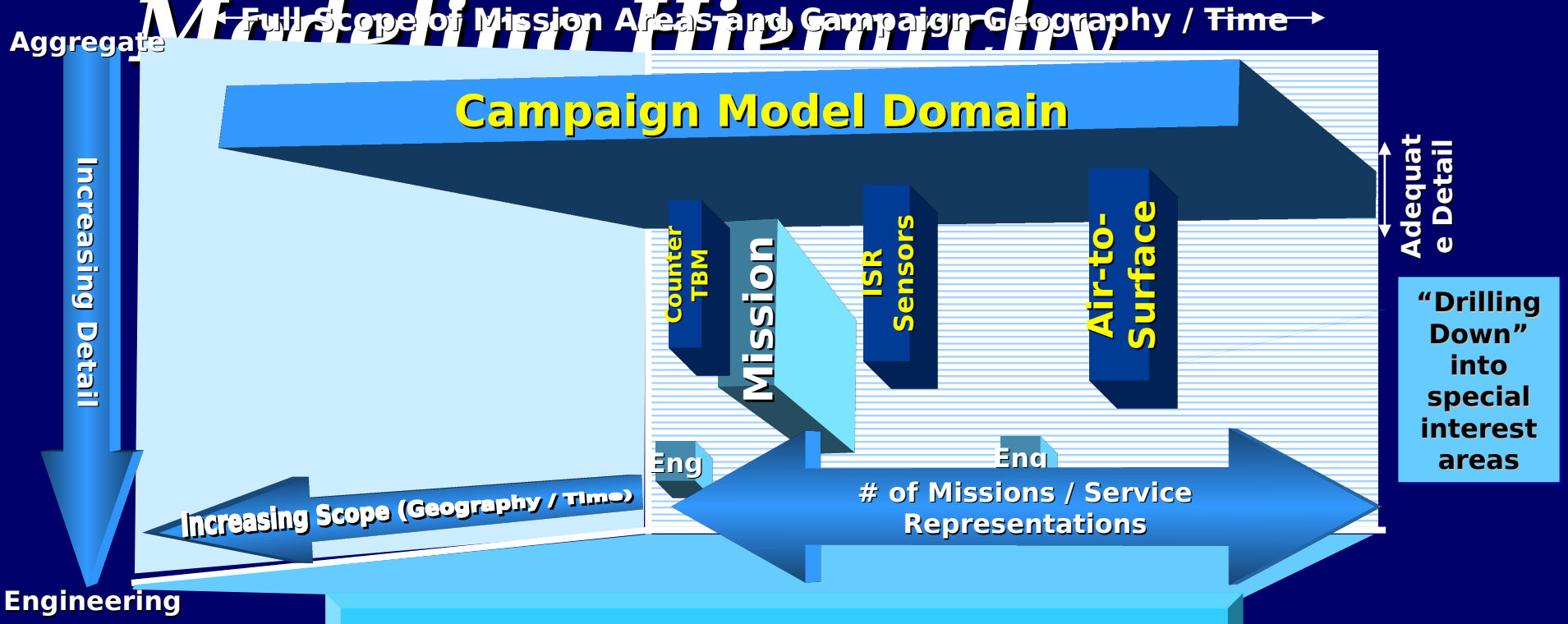
Purpose

- Describe the current state of C^2 in campaign analysis models
- Show where the technology is headed
- Propose a means for injecting real-time analysis into the aerospace campaign planning process

Overview

- Campaign analytic simulation defined
- Current C^2 capability: THUNDER
- Next-generation modeling:
  - STORM
  - Advanced Comms Analysis Project (AFRL - Rome)
- Analysis in real-world planning
  - The Automated Aerospace Tasking Analysis Capability (AATAC) concept

Campaign Analytic Simulations Defined: The Modeling Hierarchy



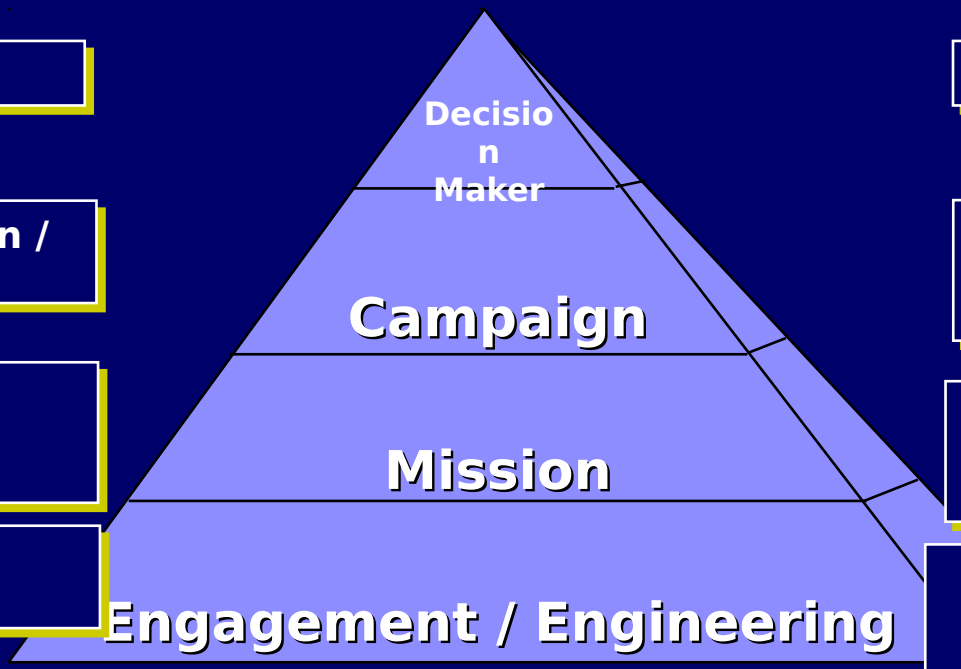
Campaign Simulation Characteristics

- Wide breadth in missions / representations
- Large scope in geography / time
- Shallow depth in detail
  - Abstract and aggregate
  - Effects-based
  - Reliance on more detailed models for effects

Campaign Analytic Simulations Defined: The Analytic Hierarchy

What We Look At

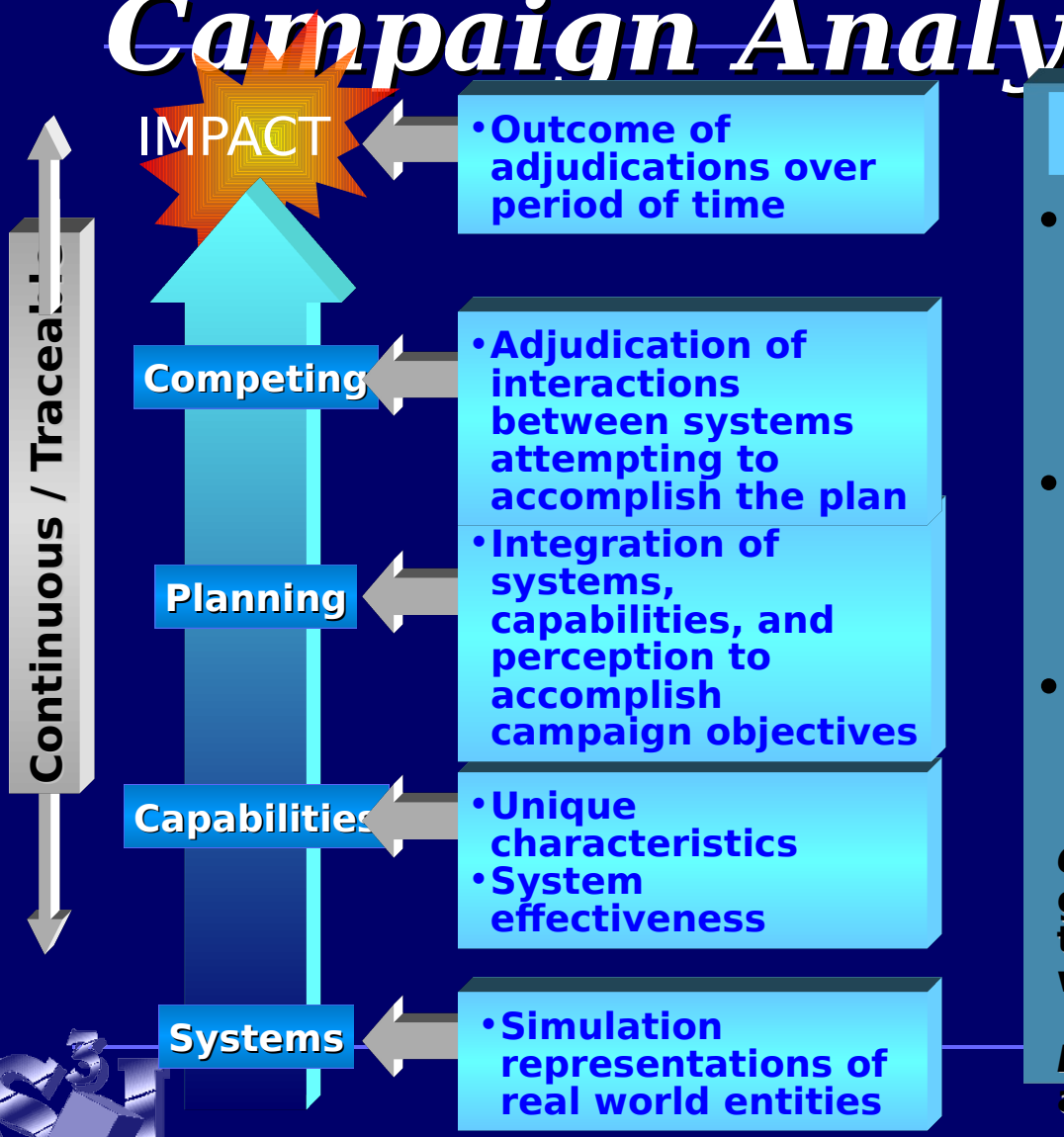
- **Cost-Effectiveness**
- **Resource Allocation / Competition**
- **Multi-system Integration / Capabilities**
- **Single System Characteristics**



What We Discove

- ***"What should I do?"***
- **Measures of Outcome / Impact *"So what?"***
- **Measures of Effect *"How does it help me?"***
- **Measures of Performance *"How good is it?"***

Capturing Impact in Campaign Analysis



The "Thread"

- *A traceable process linking systems and their capabilities to campaign impacts*
- *A means for assessing the impact of a system on a campaign outcome*
- *The guideline for balanced simulation development*

***Good News*: Threads are generally understood for most traditional logistics, mobility, and warfighting categories.**

***Bad News*: Space, C², and other areas still require much research**

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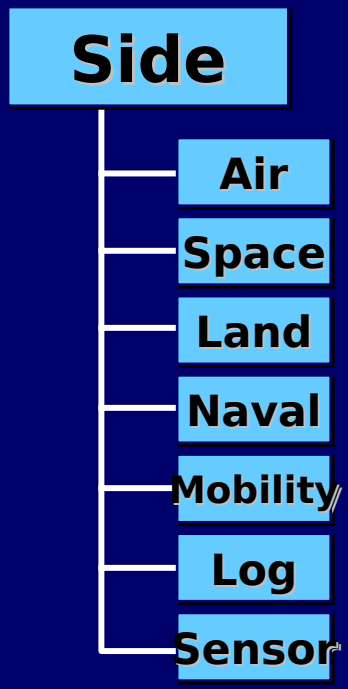
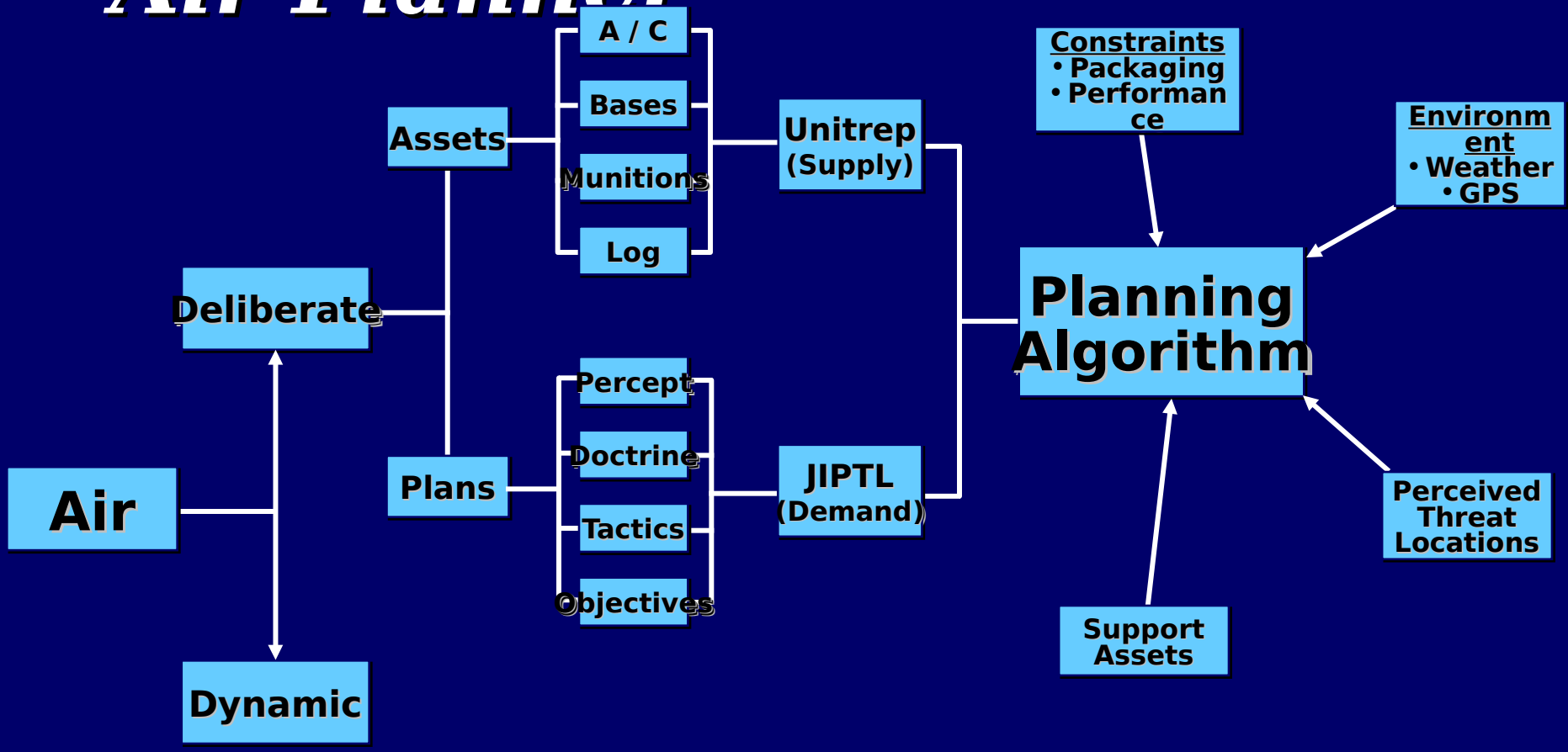
Current C² Capability: THUNDER

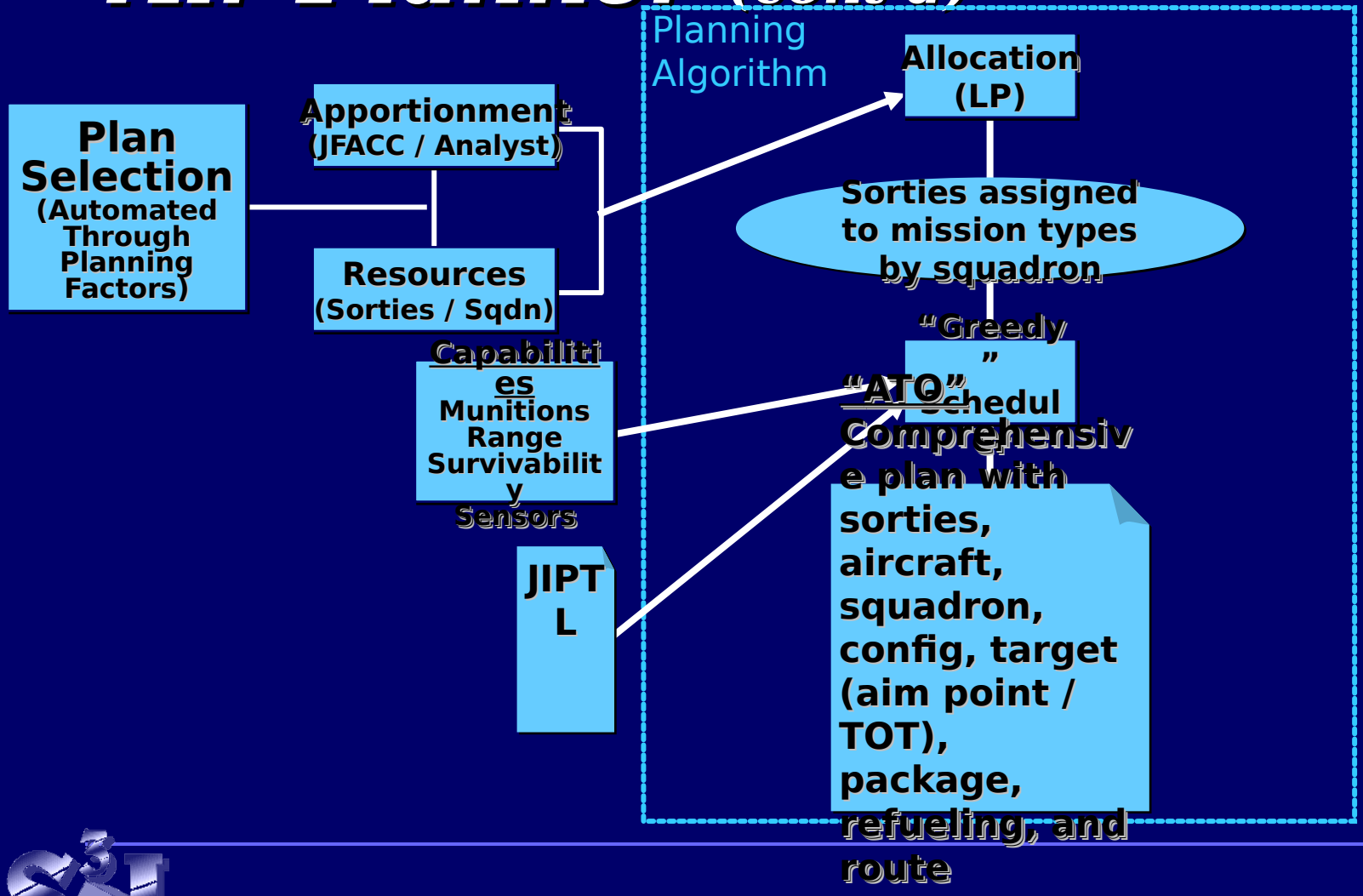


- Function-oriented planners
  - Run unattended for duration of conflict
- Driven by the state of the campaign
  - Planner Objectives:
    - Achieve a desired set of user defined goals
  - How Accomplished:
    - User input strategy / doctrine / tactics
    - Internal algorithms responsive to campaign state

THUNDER C² Example: Air Planner



THUNDER C² Example: Air Planner (cont'd)



Comms in THUNDER

- Basic comms modeling capability - not explicit
- Approach:
  - Targetable entities are linked to specific planning functions
  - Destruction of entities results in delays / reduced information to deliberate planning or dynamic response activities
  - Reconfigurable through robust, analyst-controlled planning factors
- Example: Destroying a C^3 node delays ISR information to the Air Planner

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Transitioning to Future C² Analysis Capabilities: Philosophy

- Evolutionary approach
  - Begin with what we know in THUNDER
  - Add what we've learned over the years
  - Design for expansion / growth: Lifecycle viewpoint vs. a single-point solution viewpoint
- Fix the shortfalls
  - Consistent approach throughout the model
  - Greater flexibility for analytic experiments
- Focus on campaign effects
  - Still not designed to represent details or undiscovered concepts

The Purposes of STORM

- Support JWARS development
  - Technical Risk Reduction
    - Interaction Test Bed
    - Algorithm Test Bed
  - Programmatic Risk Reduction
    - Safety Net

Joint Warfare System

- Independent Air Force Analytic Tool
  - Continued interaction and algorithm assessment until JWARS is fielded
  - Wargame Support
  - Exercise Support
  - Relationship with NASM

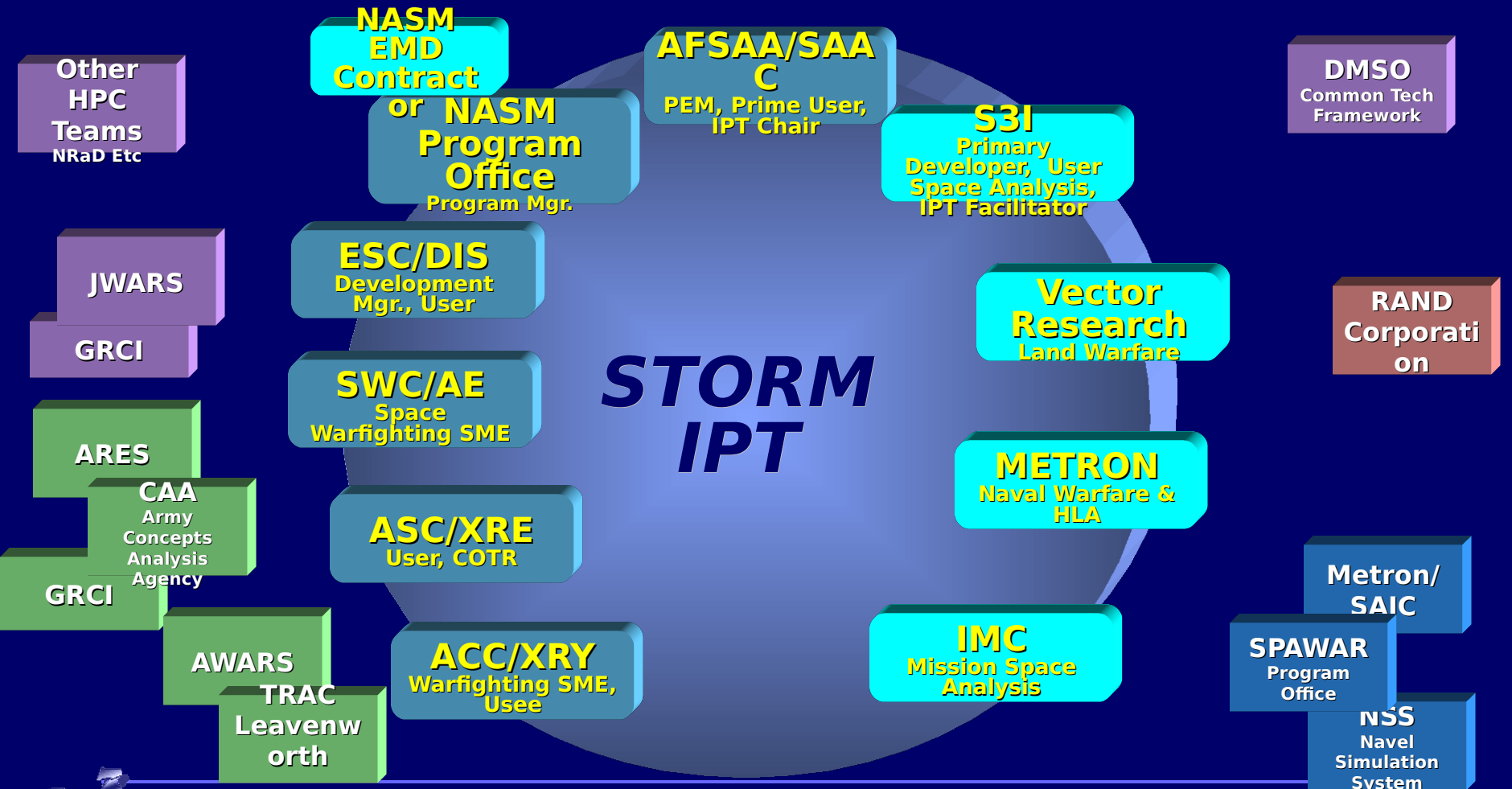
Synthetic Theater Operations Research Model

The Mission of STORM

Provide air campaign analysts with high quality, DoD *compliant* campaign analysis system incorporating *proper, believable representations* of warfighting activities, a robust database capability, and flexible, *functional* user interfaces.

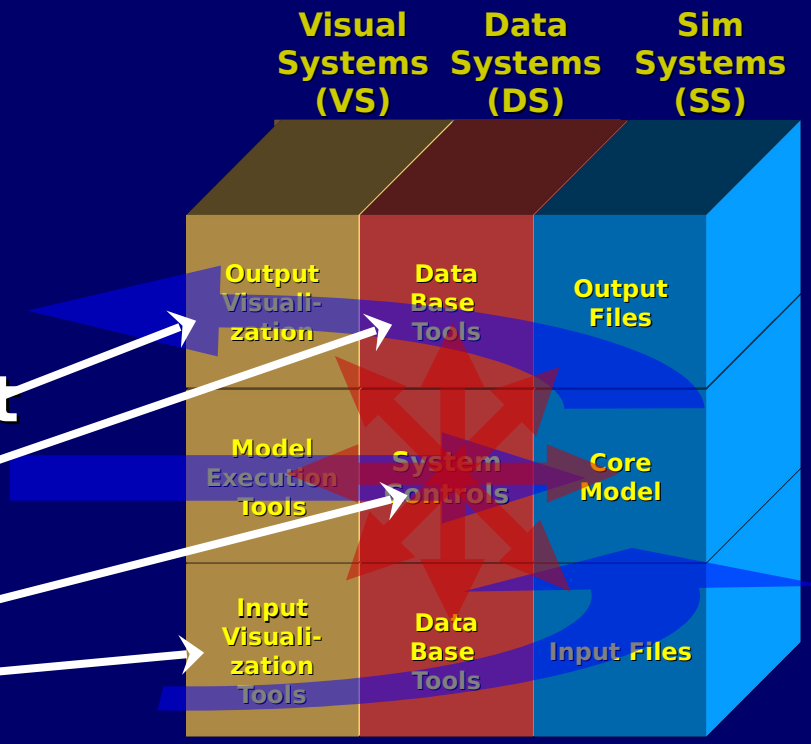
The STORM Team

And Associates



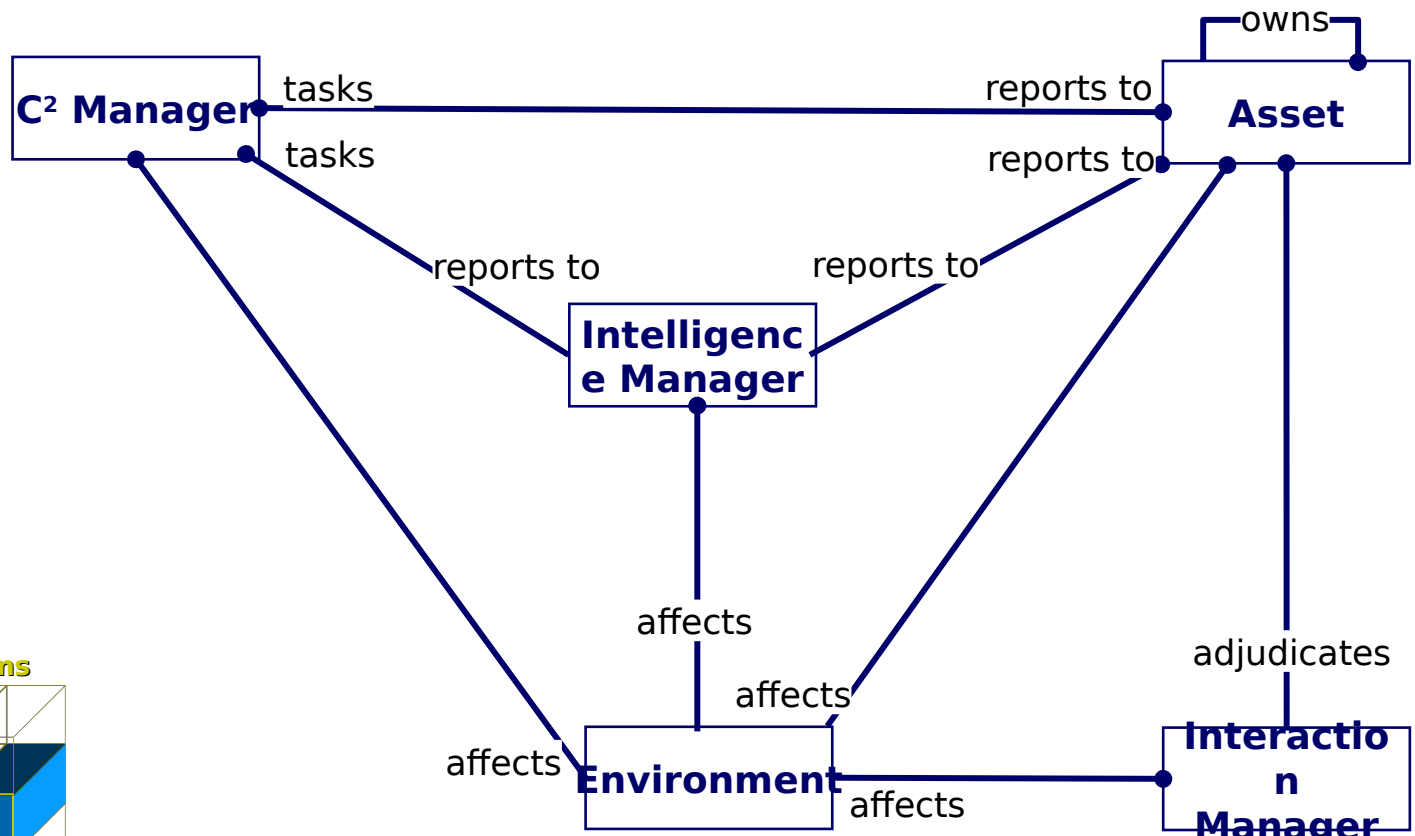
The STORM System Architecture

- Open Architecture (with an HLA capability)
  - Industry standard where available
    - C++
    - Object Oriented
  - "Highly Reconfigurable" at system component level
    - Any statistical package
    - Any database program
    - Any configuration mgt system
    - Any analytic DOE tool
  - Hardware platform portability
    - Currently running on Sun Solaris and Intel-PC Linux



Common Analysis Simulation Architecture (CASA)

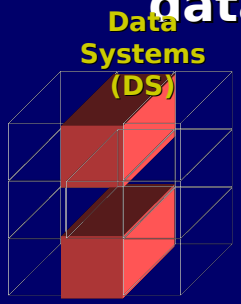
STORM Meta-Model (SS)

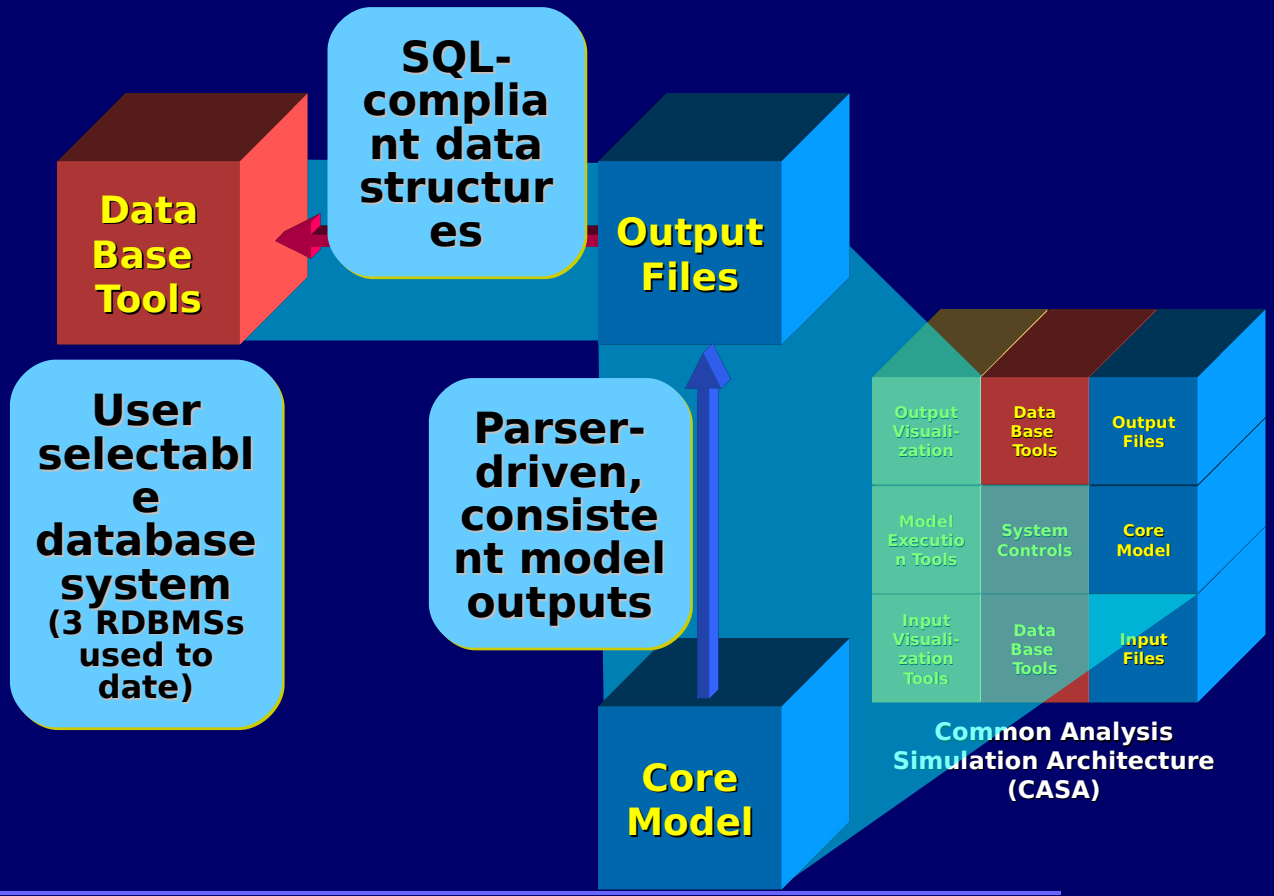


Sim Systems (SS)

STORM Data System (DS)

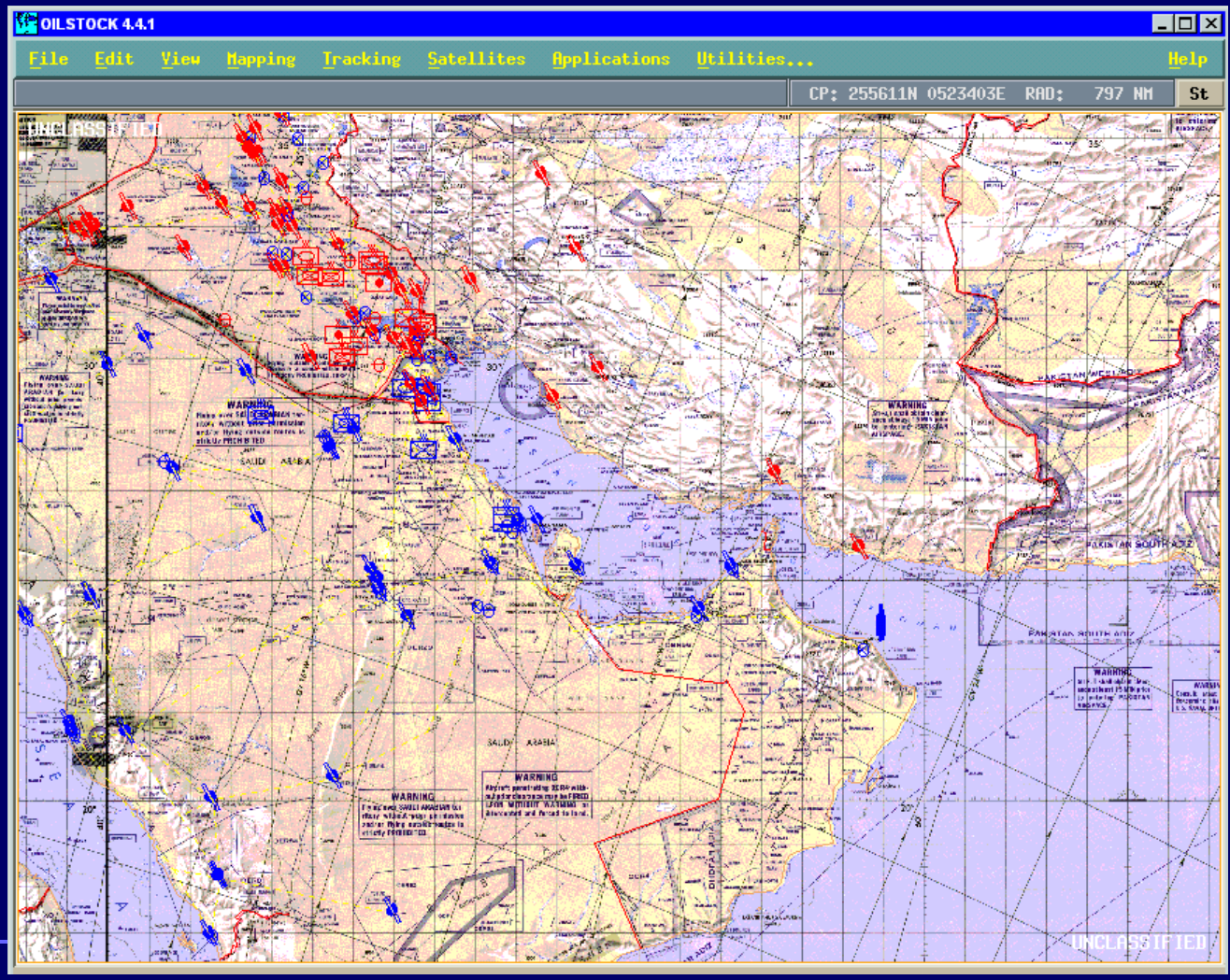
- **Database Advances**
  - **All user-defined, simulation outputs captured in a self-defining, SQL compliant, relational database**





STORM Visualization *(an example)*

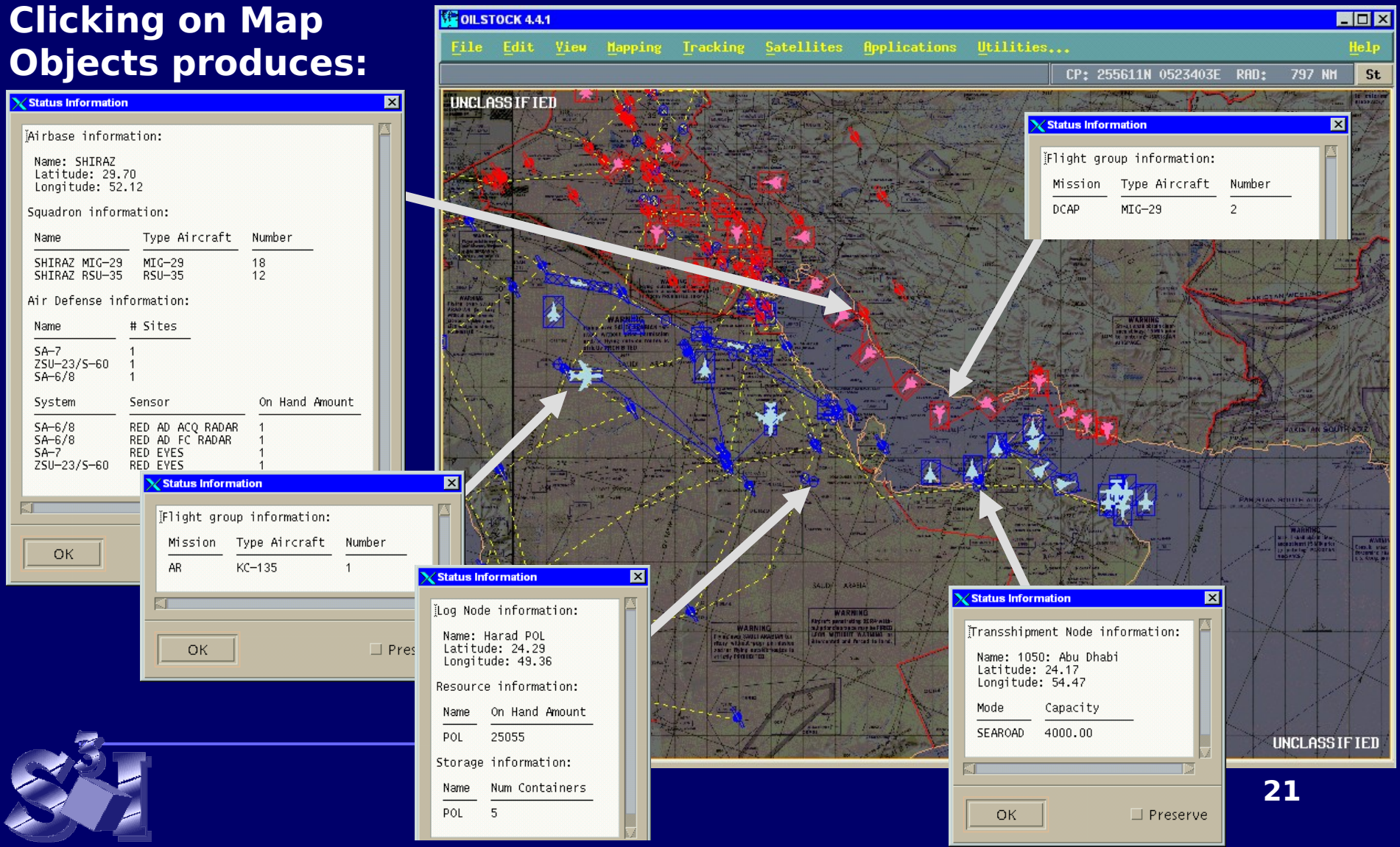
- Oilstock GOTS Software
- NIMA Standard Maps
- S3I Interface
- User-Defined Displays, Queries



Visual Systems (VS)

STORM Visualization (Maptool Queries)

Clicking on Map Objects produces:



Tackling the Hard Problems

1998: STORM

- STORM's "Year of Space" CMMS
- **1999**:
  - Initial implementation of Space CMMS portions in STORM

Knowledge Capture

1998: THUNDER

- Major space implementations:
  - Area Search Sensors (Space-Based Radar)
  - Space-Based Navigation (GPS)
  - SIGINT
  - Launch on Demand
  - Initial Space Control concepts

Tackling the Hard Problems

1999: STORM

- STORM's "Year of C^2" CMMS
- **2000**:
  - Initial implementation of C^4 CMMS portion in STORM

Knowledge Capture

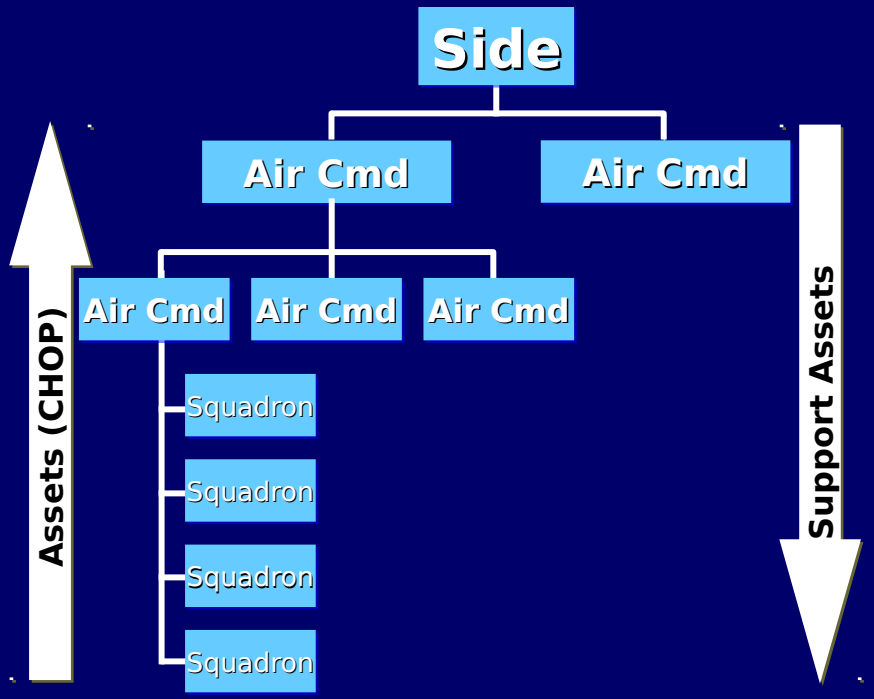
1999: THUNDER (Proposed - CCB in Dec 98)

- TBM impact point prediction (SBIRS)
- Sensor-to-shooter
- Air MTI Space Based Radar
- ISR / Comm processing impacts

STORM C²: A Philosophical Shift

A flexible, hierarchical, *doctrinally-neutral* approach

- Each side possesses an independent set of planning functions
- Each planning function can be arranged into analyst-designed hierarchies
  - Same level commands can be C² independent
  - Higher commands own lower commands
    - Lower commands may "chop" assets to the higher command within hierarchy
    - Lower commands may share higher command's support assets



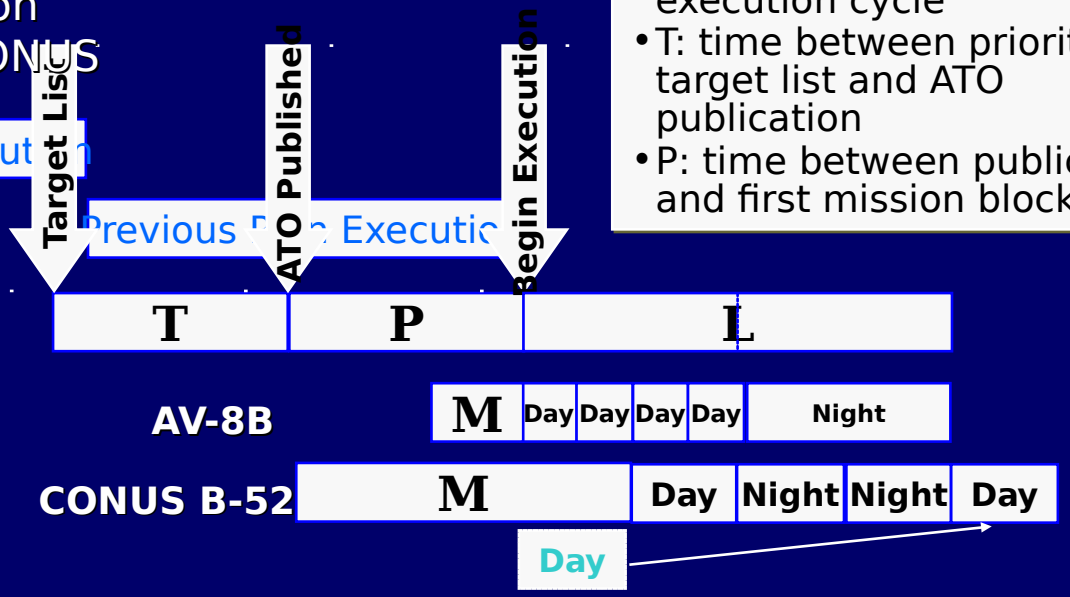
Example Air Planner

Capturing New Concepts: The Planning Cycle

User definable planning periods

- Addresses scheduling challenge of short planning cycles and long duration missions (HAE-UAV, CONUS Bomber)

Air Cmd ATO Parameters
- L: length (in time) of plan execution cycle
- T: time between prioritized target list and ATO publication
- P: time between publication and first mission block



Air Unit Defined ATO Parameters
- M: min time between publication and first mission block
- D: number of day blocks
- N: number of night blocks

Allows analysis of candidate ATO cycle / timing issues and value of information for long endurance missions

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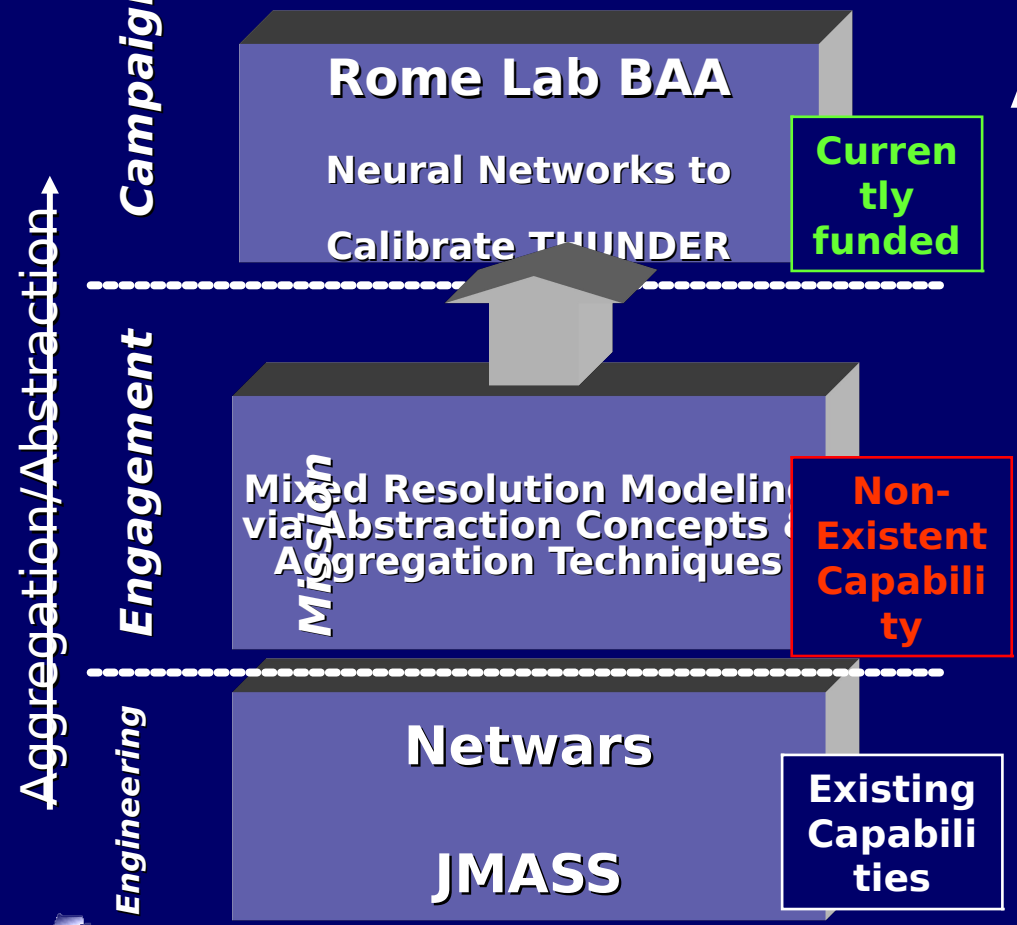
Advanced Comms Analysis Project



A research project that:

- Leverages existing simulation outputs
- Attempts to convert engineering-level outputs into campaign-level impacts
- Employs trained neural networks to drive dynamically the state of C^2 in a campaign simulation

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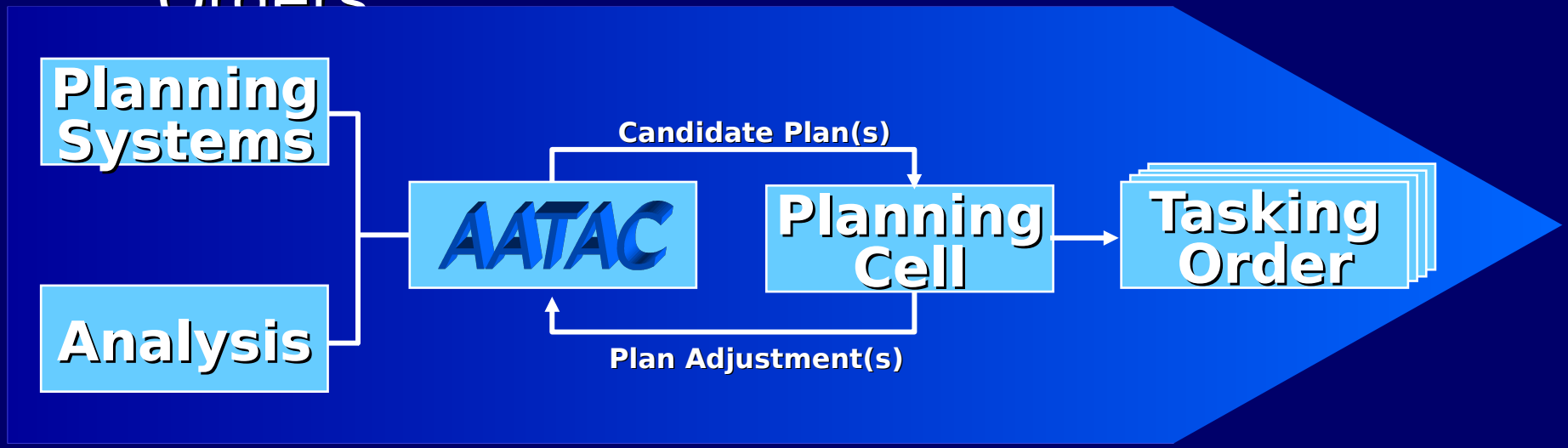
Purpose of AATAC

- Provide an automated capability for rapidly building, analyzing, adjusting, and comparing candidate Tasking Orders



Background

- ***AATAC*** conceived to provide major improvements in planning process
  - **Rapid** Tasking Order development
  - Near **real-time** analysis of TOs
  - Potential for **look-ahead** analysis

How AATAC Will Work

1. ***AATAC*** reads in appropriate planning information from a real world planning system
2. ***AATAC*** produces a candidate Tasking Order in a matter of minutes
3. Planners analyze the Tasking Order for:
   - Adherence to objectives
   - Weapon system employment
   - Overall effectiveness
4. The ***AATAC*** process is iterated until the desired plan is developed

AATAC Benefits

- **Rapid Production of Candidate Tasking Orders**
  - Adapts to shorter planning cycles
  - “Best Available” plan always available - First one in minutes, follow-on plans as they become refined
- **Formal analysis of each candidate plan**
  - AATAC will provide tools to compare the “goodness” of alternative plans
  - Planners will be able to explore “what-if” alternative plans
- **Location independence**
  - “Reachback” capable (wherever there’s real-world planning systems access ***AATAC*** can run)

Description of AATAC
The Foundation

- ***AATAC*** combines two existing technologies

TBMCS

Migration Standard for DoD planning C²

Semi-Automated
- JTF/JFACC objectives
- Prioritized targets
- Available weapons systems
- Available weapons
- Weather
- Threats and locations

THUNDER

Standard USAF Campaign Analysis Simulation

Automated
- Targeteering
- Weaponeering
- Force packaging
- Basic route planning
- Support systems

AATAC

Description of AATAC
Help for Planners

- ***AATAC*** generates a candidate Tasking Order for planners to analyze.

Plan Analysis for Suitability to Objectives, Effectiveness, and Outcomes

Inserting Formal Analysis into the Planning Process

AATAC

Integrated Real-World Data and Analytic Simulation

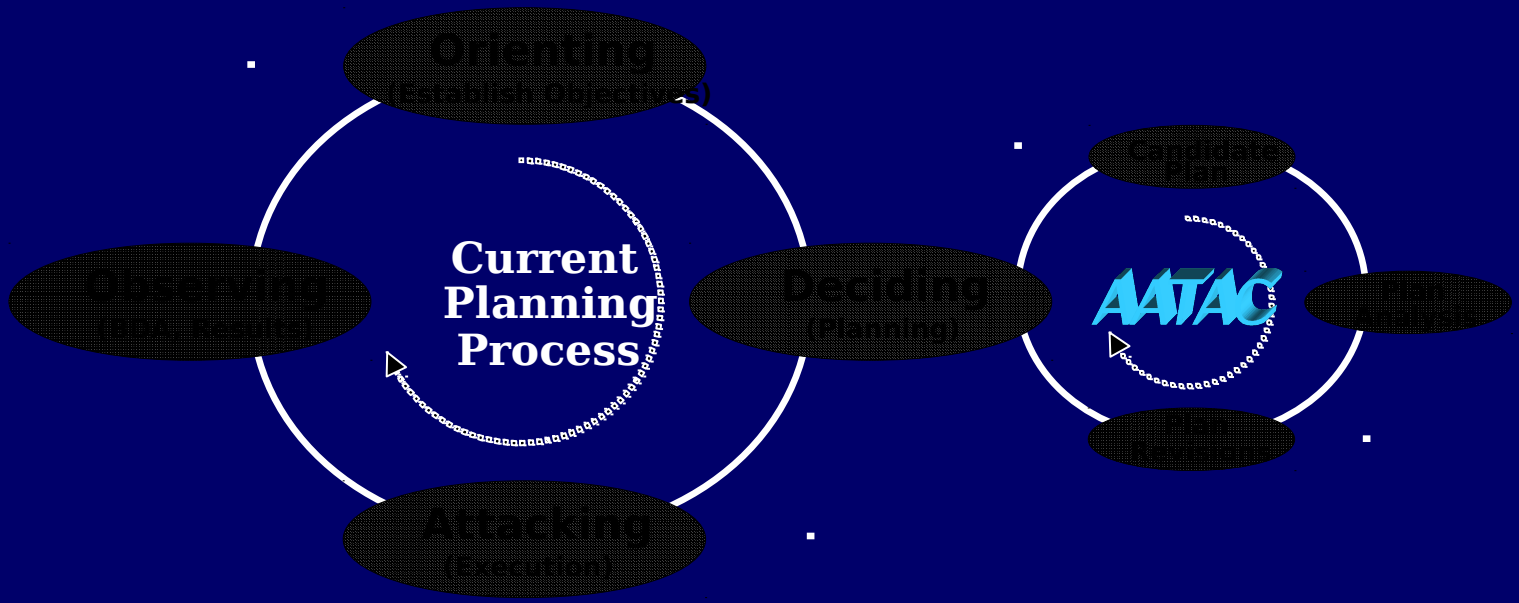
Automated Tasking Order

Candidate Plan(s)

Final Tasking Order

Description of AATAC
A Catalyst for Planning

- ***AATAC*** will help speed up the overall planning cycle



Classic OODA Loop Planning Process

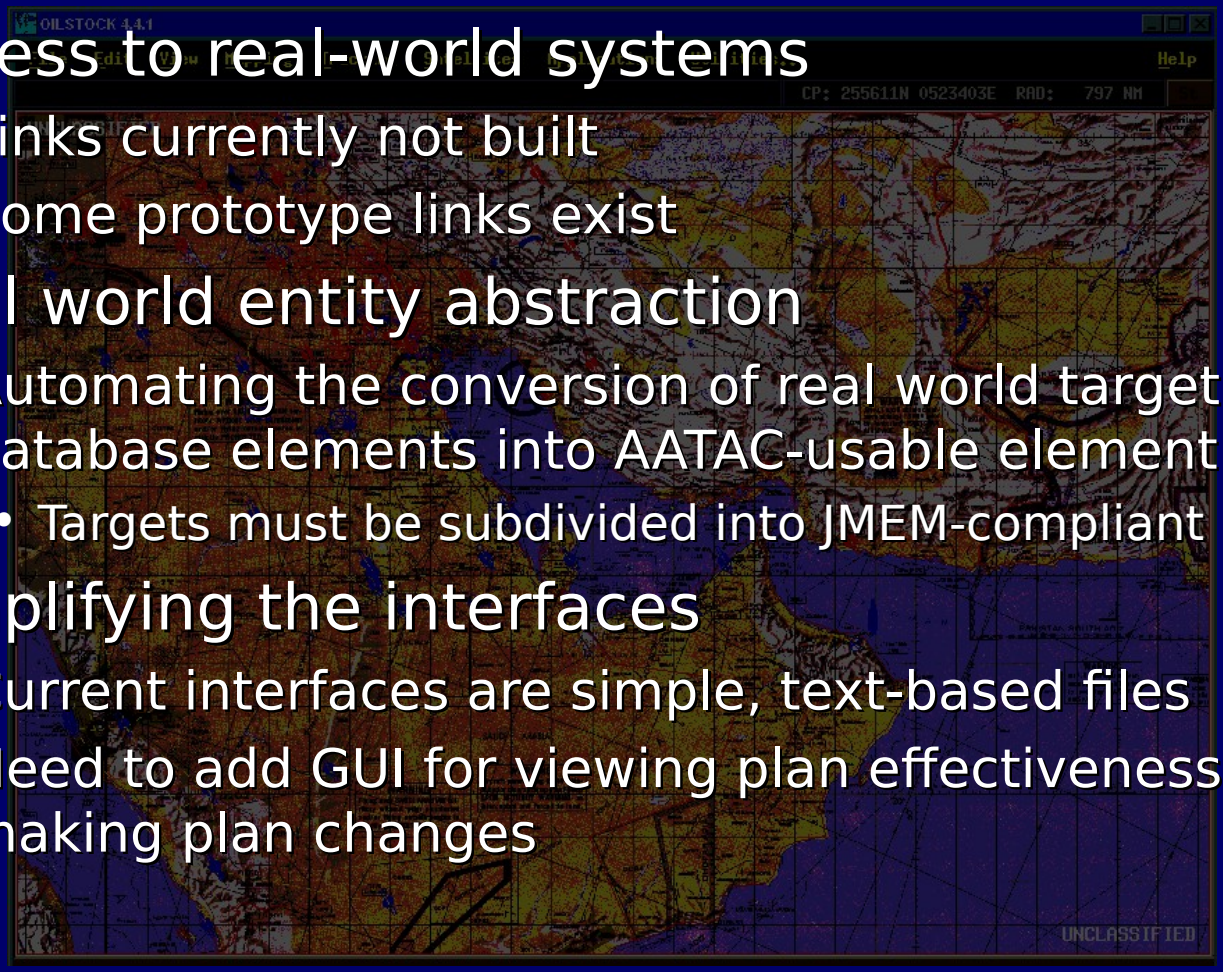
***AATAC* Process: Multiple Iterations per OODA Loop**

AATAC: What's Available When?

- **Now**:
  - THUNDER campaign simulation with automated Task Order generator
  - Real world planning systems like CIS, JMCIS, AFMSS, JPT
- **Near-Term**:
  - Integration between THUNDER planner and real-world information systems
  - TBM Core Systems
  - The Synthetic Theater Operations Research Model, STORM, the THUNDER follow-on

Key Challenges

- Access to real-world systems
  - Links currently not built
  - Some prototype links exist
- Real world entity abstraction
  - Automating the conversion of real world target database elements into AATAC-usable element
    - Targets must be subdivided into JMEM-compliant DMPIs
- Simplifying the interfaces
  - Current interfaces are simple, text-based files
  - Need to add GUI for viewing plan effectiveness and making plan changes



AATAC Summary

- ***AATAC*** will improve the planning process by:
  - Automating some of the Tasking Order development
  - Injecting analysis into the cyclic planning process
  - Shortening the planning cycle

Overall Conclusions

- Campaign-level analytic simulations currently possess acceptable C^2 for past and current studies
- Advances in technology and resultant changes in doctrine require new approaches in representing C^2 in analyses
- Future analytic simulations must focus on flexibility, responsiveness, and life-cycle design to properly represent near and far-term C^2 concepts